

What is claimed is:

Sub B1

1. A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing, characterized in that the polishing step comprises a first polishing step of polishing the surface such that the interconnect metal film partially remains on the surface other than the concave and a second polishing step of polishing the surface using a polishing slurry controlling a polishing-rate ratio of the interconnect metal to the barrier metal to 1 to 3 both inclusive until the surface of the insulating film other than the concave is substantially completely exposed.

Sub a1

2. The process for forming a metal interconnect as claimed in Claim 1, wherein polishing is conducted such that the interconnect metal film remains in 5 % to 30 % both inclusive of the surface area other than the concave.

Sub B2

3. The process for forming a metal interconnect as claimed in Claim 1, wherein in the first polishing

B2
step, the polishing slurry comprises a polishing material,
an oxidizing agent, an organic acid and an alkanolamine
5 represented by general formula (1):

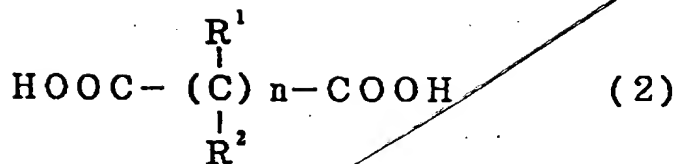


where R^1 is hydrogen or alkyl having 1 to 5 carbon
atoms; R^2 is alkylene having 1 to 5 carbon atoms; m is an
integer of 0 to 2 both inclusive; and n is a natural
10 number of 1 to 3 both inclusive, provided that $m+n$ is 3.

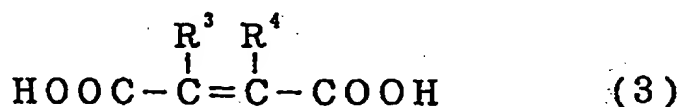
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4. The process for forming a metal interconnect
as claimed in Claim 3, wherein the alkanolamine in the
polishing slurry used is at least one selected from the
group consisting of ethanolamine, diethanolamine and
5 triethanolamine.

Sub B3
5. The process for forming a metal interconnect
as claimed in Claim 1, wherein the polishing slurry used
in the second polishing step controls a polishing rate
ratio of the insulating film to the barrier metal to 0.01
5 to 0.5 both inclusive.

6. The process for forming a metal interconnect
as claimed in Claim 1, wherein the polishing slurry used
in the second polishing step comprises a silica polishing
material and a carboxylic acid represented by general
5 formula (2):



where n is 0, 1, 2 or 3 and each of R¹ and R² is, independently for a carbon atom to which it attaches, hydrogen, -OH or -COOH; or general formula (3):



where each of R³ and R⁴ is independently hydrogen or -OH.

7. The process for forming a metal interconnect as claimed in Claim 6, wherein the carboxylic acid in the polishing slurry used is at least one selected from the group consisting of oxalic acid, malonic acid, tartaric acid, malic acid, glutaric acid, citric acid and maleic acid.

8. The process for forming a metal interconnect as claimed in Claim 1, wherein the polishing slurry used in the second polishing step comprises a silica polishing material and an inorganic salt.

9. The process for forming a metal interconnect as claimed in Claim 8, wherein the inorganic salt in the

polishing slurry used in polishing is at least one selected from the group consisting of a hydroacid salt,
5 an oxo acid salt, a peroxo acid salt and a halogen oxo acid salt.

10. The process for forming a metal interconnect as claimed in Claim 1, wherein the polishing slurry used in the second polishing step comprises an oxidizing agent.

11. The process for forming a metal interconnect as claimed in Claim 10, wherein the polishing slurry used in the second polishing step comprises benzotriazole or its derivative.

12. The process for forming a metal interconnect as claimed in Claim 1, wherein the barrier metal film is a tantalum-containing metal film and the interconnect metal film is a copper or copper alloy film.

13. A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an
5 interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical

polishing, characterized in that the polishing step
comprises a first polishing step of polishing the surface
10 using a polishing slurry comprising a polishing material,
an oxidizing agent, an organic acid and an alkanolamine
represented by the general formula (1):



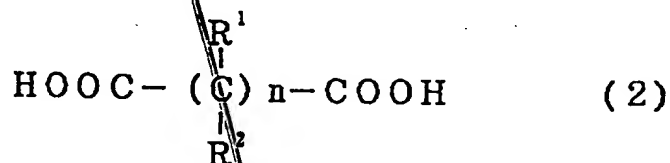
(where R^1 is hydrogen or alkyl having 1 to 5 carbon
15 atoms; R^2 is alkylene having 1 to 5 carbon atoms; m is an
integer of 0 to 2 both inclusive; and n is a natural
number of 1 to 3 both inclusive, provided that $m+n$ is 3),
such that the interconnect metal film does not remain on
the surface other than the concave while the barrier
20 metal film is not completely removed by polishing and a
second polishing step of polishing the surface using a
polishing slurry controlling a polishing-rate ratio of
the interconnect metal to the barrier metal to 1 or less,
until the surface of the insulating film other than the
25 concave is substantially completely exposed.

14. The process for forming a metal interconnect
as claimed in Claim 13, wherein the alkanolamine in the
polishing slurry used is at least one selected from the
group consisting of ethanolamine, diethanolamine and
5 triethanolamine.

15. The process for forming a metal interconnect

as claimed in Claim 13, wherein the polishing slurry used in the second polishing step controls a polishing rate ratio of the insulating film to the barrier metal to 0.01 to 0.5 both inclusive.

16. The process for forming a metal interconnect as claimed in Claim 13, wherein the polishing slurry used in the second polishing step comprises a silica polishing material and a carboxylic acid represented by general formula (2):



where n is 0, 1, 2 or 3 and each of R¹ and R² is, independently for a carbon atom to which it attaches, hydrogen, -OH or -COOH; or general formula (3):



where each of R³ and R⁴ is independently hydrogen or -OH.

17. The process for forming a metal interconnect as claimed in Claim 16, wherein the carboxylic acid in the polishing slurry used is at least one selected from the group consisting of oxalic acid, malonic acid,

5 tartaric acid, malic acid, glutaric acid, citric acid and maleic acid.

18. The process for forming a metal interconnect as claimed in Claim 13, wherein the polishing slurry used in the second polishing step comprises a silica polishing material and an inorganic salt.

19. The process for forming a metal interconnect as claimed in Claim 18, wherein the inorganic salt in the polishing slurry used in polishing is at least one selected from the group consisting of a hydroacid salt, an oxo acid salt, a peroxo acid salt and a halogen oxo acid salt.

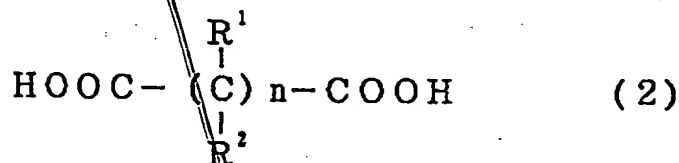
20. The process for forming a metal interconnect as claimed in Claim 13, wherein the polishing slurry used in the second polishing step comprises an oxidizing agent.

21. The process for forming a metal interconnect as claimed in Claim 20, wherein the polishing slurry used in the second polishing step comprises benzotriazole or its derivative.

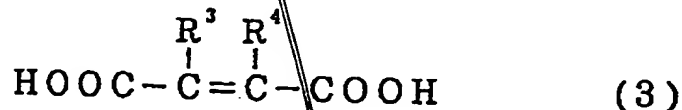
22. The process for forming a metal interconnect as claimed in Claim 13, wherein the barrier metal film is

a tantalum-containing metal film and the interconnect metal film is a copper or copper alloy film.

23. A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing using a polishing slurry comprising a silica polishing material and a carboxylic acid represented by general formula (2):



where n is 0, 1, 2 or 3 and each of R¹ and R² is, independently for a carbon atom to which it attaches, hydrogen, -OH or -COOH; or general formula (3):



where each of R³ and R⁴ is independently hydrogen or -OH.

24. The process for forming a metal interconnect

as claimed in Claim 23, wherein the polishing slurry used in polishing comprises at least one carboxylic acid selected from the group consisting of oxalic acid,
5 malonic acid, tartaric acid, malic acid, glutaric acid, citric acid and maleic acid.

25. The process for forming a metal interconnect as claimed in Claim 23, wherein the polishing slurry comprises an oxidizing agent.

26. The process for forming a metal interconnect as claimed in Claim 25, wherein the polishing slurry comprises benzotriazole or its derivative.

27. The process for forming a metal interconnect as claimed in Claim 23, wherein the barrier metal film is a tantalum-containing metal film and the interconnect metal film is a copper or copper alloy film.

Sub 937 28. A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an
5 interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical

polishing using a polishing slurry comprising a silica polishing material and an inorganic salt.

29. The process for forming a metal interconnect as claimed in Claim 28, wherein the inorganic salt in the polishing slurry used in polishing is at least one selected from the group consisting of a hydroacid salt, an oxo acid salt, a peroxy acid salt and a halogen oxo acid salt.

30. The process for forming a metal interconnect as claimed in Claim 28, wherein the polishing slurry comprises an oxidizing agent.

31. The process for forming a metal interconnect as claimed in Claim 30, wherein the polishing slurry comprises benzotriazole or its derivative.

32. The process for forming a metal interconnect as claimed in Claim 28, wherein the barrier metal film is a tantalum-containing metal film and the interconnect metal film is a copper or copper alloy film.